Chili pepper (capsicum annum l. var. cayenne) as feed additive for rabbits

Ají (capsicum annuum l.var. cayenne) como aditivo alimentario para conejos

***Gastón Adolfo Castaño Jiménez*[1]**

Abstract

Chili is used as a substitute for growth promoting antibiotics in animal production. The objective of this work was to evaluate the effect of supplementation with Chili Powder (*Capsicum annum* L. var. Cayenne) on fattening rabbits consuming commercial concentrate during the fattening phase on productive performance, carcass, digestive system size and digestibility of the diet. We used 10 rabbits of the New Zealand White breed with 30 d of age that were randomly distributed in the treatments according to a completely Randomized Experimental Design. The treatments consisted of two diets: a control in which concentrate was supplied

1 Associate Professor Faculty of Livestock Sciences. Research Group on Animal Nutrition and Feeding-Gina. Animal Nutrition Laboratory. Corporación Universitaria Santa Rosa de CabalUnisarc (Santa Rosa de Cabal, Colombia). Correspondence: gaston.castano@unisarc.edu.co

without Chili and another in which the concentrate of the control treatment was mixed with Chili Powder (20 g kg^{-1} of concentrate). Feed Chili Powder did not affect live weight (P>0.05), feed intake (P=0.6076), feed conversion rate (P=0.4849), diet digestibility (P>0.05), weight carcass (P=0.5396), weight of different portions of the digestive system (P>0.05), and the length of the small intestine (P=0.6132). Rabbits receiving Chili presented a liver with a lower relative weight (g kg^{-1} of live weight) compared to control, but not the relative weight of the carcass (P=0.4399) and the other portions of the digestive system (P>0.05). It is concluded that under the conditions of the experiment, the Chili cannot be considered as a growth promoter in rabbits, but a lower relative weight of liver should be considered in future researches.

Key words. Growth promoting antibiotics, phytogenic feed additive.

Resumen

El Ají se utiliza como sustituto de los antibióticos promotores del crecimiento en la producción animal. El objetivo de este trabajo fue evaluar el efecto de la suplementación con harina de Ají (*Capsicum annum* L.var. Cayenne) en conejos de engorde que consumieron concentrado comercial durante la fase de engorde sobre el rendimiento productivo, canal, tamaño del sistema digestivo y digestibilidad de la dieta. Se utilizaron 10 conejos de raza Blanca de Nueva Zelanda con 30 d de edad que se distribuyeron aleatoriamente en los tratamientos según un Diseño Experimental Completamente al Azar. Los tratamientos consistieron en dos dietas: una control en la que se suministró concentrado sin Ají y otra en la que el concentrado del tratamiento control se mezcló con chile en polvo (20 g kg^{-1} de concentrado). La harina de ají no afectó el peso vivo (P> 0.05), la ingesta de alimento (P=0.6076), la tasa de conversión de alimento (P=0.4849), la digestibilidad de la dieta (P> 0.05), el peso de la canal (P=0.5396), el peso de diferentes porciones del sistema digestivo (P>0.05) y la longitud del intestino delgado (P=0.6132). Los conejos que recibieron Ají presentaron un hígado con un peso relativo menor (g kg^{-1} de peso vivo) en comparación con el control, pero no el peso relativo de la canal (P=0.4399) y las otras porciones del sistema digestivo (P> 0.05) . Se concluye que bajo las condiciones del experimento, el Ají no puede ser considerado como un promotor del crecimiento en conejos, pero se debe considerar un menor peso relativo de hígado en futuras investigaciones.

Palabras clave: Antibióticos promotores de crecimiento, aditivos alimenticios fitogenéticos

1.Introduction

The antibiotic growth promoters (**AGP**) improves the production performances of rabbits (Falcão et al., 2007), but its residue in animal products gradually created antibiotic resistant microbes (Thiamhirunsopit et al., 2014). The limited use of **AGP** as the feed supplement has stimulated investigations on alternative feed additives in animal nutrition (Corduk et al., 2013), like natural substances (Thiamhirunsopit et al., 2014) called phytogenic compounds (Mountzouris et al., 2011). Phytogenic feed additives are plant-derived products used in animal feeding to improve the performance of agricultural livestock and are discussed possibly to add to the set of nonantibiotic growth promoters (Windisch et al., 2008).

Peppers from Capsicum species are native to the tropical and humid zones of Central and South America. They are commonly used as a spice or food and also for a broad variety of therapeutic applications. Capsaicin, the main representative of the pungent components, is a lipophilic alkaloid and has been used in clinical practice (Zimmer et al., 2012) with antimicrobial activities (Al-Kassie et al., 2011; Zimmer et al., 2012) against pathogenic bacteria, such as *Escherichia coli*, *Clostridium perfringens*, and *Salmonella enteritidis* (Corduk et al., 2013). Chili has been used as a substitute for antibiotics (Thiamhirunsopit et al., 2014) and has been evaluated in broilers (Al-Kassie et al., 2011, Atapattu and Belpagodagamage, 2011, Thiamhirunsopit et al., 2014), laying hens (Lokaewmanee et al., 2013) and pigs (Manzanilla et al., 2006). We didn't find any studies in which Chili was used in rabbit feeding.

The small producers of rabbits usually supply the commercial concentrate with various plant materials in order to make the diet more efficient and improve the animal health. The aim of this work was to evaluate the effect of supplementing with Chili Powder (*Capsicum annum* L. var Cayenne) to rabbits that consume commercial concentrate during the fattening phase on the productive performance, the carcass and the digestibility of the diet.

2. Materials and Methods

Location

This experiment was performed in an experimental farm "El Jazmín" of Unisarc University, located in Santa Rosa de Cabal (Risaralda, Colombia) at 4º52'07" N, 75º37'22" W and 1701 masl. Average temperature of 18.6 °C and average yearly precipitation is 2620 mm yr^{-1}. This experiment was carried out between April and May 2015.

Duration and treatments

The experiment lasted 35 d (7 d of adjustment to the metabolic cages, and a collection period of 28 d). The treatments consisted of two diets supplied to rabbits during the fattening phase that were differentiated according to the inclusion of Chili Powder: a control where commercial concentrate was supplied without Chili Powder and another in which the concentrate of the control treatment was mixed with Chili Powder (20 g kg^{-1} of concentrate).

The Chili Powder was prepared by grinding dried chili (60°C/36 h) through 2 mm diameter sieve blender. Chemical composition of concentrate and Chili Powder used for the experiment are presented in Table 1.

Table 1. *Chemical composition concentrate and Chili meal used for the experiment*

Component	Concentrate	Chili
Dry matter (**DM**), g kg^{-1}	868.5	876.0
Crude protein (**CP**), g kg^{-1} **DM**	172.9	90.2
Neutral detergent fiber (**NDF**), g kg^{-1} **DM**	319.8	382.8
Acid detergent fiber (**ADF**), g kg^{-1} **DM**	170.2	382.8
Non-fibrous carbohydrates (**NFC**)[3], g kg^{-1} **DM**	338.6	429.4
Acid detergent lignin, g kg^{-1} **DM**	26.8	ND[2]
Ether extract (**EE**), g kg^{-1} **DM**	71.6	37.8
Ash, g kg^{-1} **DM**	97.1	59.8
Gross energy[3], kcal kg^{-1} **DM**	4382	4236

Note. [1]**NFC** = 100 – (**CP** + **EE** + **Ash** + **NDF**) (Omer et al., 2013). [2]Not determined. [3]Gross energy was calculated by multiplying the nutrient concentrations by their heats of combustion (each g of **CP**, **EE**, carbohydrates -**NFC+NDF**- produces 5.65, 9.40 and 4.15, respectively) (Omer et al., 2013).

Animals and management

A total number of 10 male New Zealand White rabbits aged 30 d with an average body weight of 833±189 g (Ave±SD), were randomly allocated into two treatment groups with 5 replicates per treatment. Rabbits was individually kept in digestibility cages (35 x 50 x 35 cm; width x length x height). The cages were equipped with a feeder that avoid contamination of the feed by feces or urine and allowing recording individual feed intake for each rabbit; a drinker steel nipple with drainage system that avoids contamination of the feces with water; and a collection system allows quick escape of urine and individual collection of feces, urine and waste. the experimental diets and drinking water were supplied *ad libitum*. In order to ensure *ad libitum* consumption, a quantity of concentrate equivalent to the consumption of the previous day plus 20% was supplied, which was divided into two doses: the first at 7:00 h and the second at 13:00 h.

The rabbits were weighed at 30, 37 and 65 d of age (at weaning, at start of the collection period and at slaughter, respectively); the weighing was carried out at 7:00 h prior to the supply of food. The slaughtering of rabbits was made as described by Castaño and Cardona (2015) on day 35 of the experiment, when they were 65 d old. Once the animals were sacrificed, the carcass, stomach, small intestine (with and without content), caecum, colon+rectum, and liver were weighed; additionally, the length of the small intestine was measured. The digestibility test was performed for 7 d, prior to sacrifice.

Collection samples

To determine the feed intake, the waste of the previous day was weighed (at 7:00 h) it was stored at -20° C and sent to the laboratory to determine the dry matter (**DM**) concentration and correct the **DM** intake.

On day 32, 500 g of concentrate and Chili were collected. During the digestibility test the feces were collected every 2 h and stored at -20 °C in a plastic container per cage; the total excretion of feces was dehydrated at 60ºC for 48 h, it was macerated manually and passed through a strainer to remove the hairs coming from the rabbits. The samples of concentrate, chili and feces were ground through a Cyclone Sample Mill (Udy®) with 1 mm sieve and subsequently analyzed in the laboratory.

Chemical analysis

Concentrate, Chili and feces were analyzed to determine concentration of **DM** and ash (procedures AOAC-930.15 y AOAC-942.05, respectively; AOAC, 2010); crude protein (**CP**) according to Kjeldahl method (Thiex et al., 2002); ether extract (**EE**) according to Soxhlet method (procedure 920.39 AOAC, 2010); neutral detergent fiber (**NDF**), acid detergent fiber (**ADF**) and acid detergent lignin (**ADL**) were determined according to the method of Van Soest et al. (1991), using heat stable amylase. Non-fibrous carbohydrates (**NFC**) were estimated according Omer et al. (2013) using the following equation: **NFC** = 100 – (**CP** + **EE** + Ash + **NDF**). Gross energy (Kcal kg^{-1} **DM**) was calculated by multiplying the nutrient concentrations by their heats of combustion (each g of **CP**, **EE**, carbohydrates produces 5.65, 9.40, 4.15 kcal; Omer et al., 2013).

Calculations

Feed conversion rates (**FCR**) were calculated as described by Castaño and Cardona (2015) and apparent digestibility according to Perez et al. (1995).

Statistical analysis

All data in this study were statistically analyzed by one-way analysis of variance (ANOVA) using the software Statistix (version 8.0, Copyright© 1985-2003 Analytical Software). Significance was declared at P<0.05.

3. Results and Discussion

The Chili Powder did not affect live weight (**LW**) at 65 d (P=0.3044), weight gain (P> 0.05), feed intake (P=0.6076), and **FCR** (P=0.2105) (**Table 2**).

Table 2. *Effect of Chilli Powder (Capsicum annum L. var. Cayenne) dietary incorporation on growth performance in growing rabbits New Zealand White (37 and 65 d of age)*

Ítem	Treatment[1]		SEM[2]	P-value
	Control	Chilli Meal		
Live weight, g at 65 d	1969	2087	129	0.5396
Weight gain				
Total, g	1022	900	163	0.6127
Daily, g	36	32	6	0.6127
Relative[3]	1143	783	207	0.2540
Feed intake, g	3178	3346	222	0.6076
Feed conversion rate[4]	3.44	2.85	0.30	0.2105

Note. 1 Diets supplied to rabbits: a Control where commercial concentrate was supplied without Chili Meal and another in which the concentrate of the control treatment was mixed with Chilli Meal (20 g kg-1 of concentrate). 2 Standard error of a mean. 3g of weight gain per kg of weight at starting the experimental diet. 4g of feed intake per g weight gain.

The addition of Chili Powder did not affect the weight carcass (P=0.5396), the weight of different portions of the digestive system (P>0.05), and the length of the small intestine (P=0.6132). The Chili Powder in the diet affected the relative weight of the liver (g kg^{-1} live weight, P=0.0198), but not the relative weight of the carcass (P = 0.4399) and the other portions of the digestive system (P>0.05). The rabbits that received Chili had a liver with a lower relative weight compared to the control (42 and 35 g kg^{-1} of live weight for the control and Chili Powder treatment, respectively) **(Table 3)**.

Table 3. *Effect of Chilli Powder (Capsicum annum L. var. Cayenne) dietary incorporation on carcass and the size of different portions of the digestive system in growing rabbits New Zealand White (37 and 65 d of age)*

Ítem	Treatment[1]		SEM[2]	P-value
	Control	Chilli Meal		
Carcass weight, g	1040	1129	86	0.4849
Weight digestive system, g				
Stomach	98	91	5	0.3170
Small intestine + content	63	67	5	0.6292
Small intestine	55	60	6	0.6502
Caecum	91	111	10	0.1837
Colon + rectum	47	56	6	0.3588
Liver	83	73	5	0.2239
Small intestine length, cm	257	235	30	0.6132
Relative weight, g kg^{-1} Live Weight				
Canal	526	540	12	0.4399
Stomach	50	44	3	0.2112
Small intestine + content	32	32	1	0.9058
Small intestine	28	29	2	0.6955
Caecum	46	53	3	0.1532
Colon + rectum	25	27	4	0.6791
Liver	42	35	2	0.0198

Note. 1 Diets supplied to rabbits: a Control where commercial concentrate was supplied without Chili Meal and another in which the concentrate of the control treatment was mixed with Chilli Meal (20 g kg-1 of concentrate). 2 Standard error of a mean.

The supply of chili pepper did not affect the digestibility of the **DM** (P =1.0000), **OM** (P=0.9433), **CP** (P=0.5375), **EE** (P=0.9429), carbohydrates (P=0.7546), and gross energy (P=0.9747) **(Table 4)**.

Table 4. *Effect of Chilli Powder (Capsicum annum L. var. Cayenne) dietary incorporation on apparent digestibility[1] of diet in growing rabbits New Zealand White (37 and 65 d of age)*

Feed fraction	Treatment[2]		SEM[3]	P-value
	Control	Chilli Meal		
Dry matter	698.3	698.3	9.3	1.0000
Organic matter	716.3	717.3	9.5	0.9433
Crude protein	785.8	771.0	16.0	0.5375
Ether extract	789.0	792.3	30.8	0.9429
Carbohydrate[4]	690.3	695.0	10.3	0.7546
Gross energy	727.0	726.5	10.7	0.9747

Note. 1 g of feed fraction digested per kg of feed fraction consumed. 2Diets supplied to rabbits: a Control where commercial concentrate was supplied without Chili Meal and another in which the concentrate of the control treatment was mixed with Chilli Meal (20 g kg-1 of concentrate). 3Standard error of a mean. 4Carbohydrates = 100 – (CP + EE + Ash)

The use of **AGP** improves the productive performance of the animals and the efficiency of the diet; but its use is currently restricted due to a negative effect on human health. The additives used as alternatives to **AGP** have been studied mainly in pigs and chickens, and due to the particular characteristics of rabbit digestive physiology, it can be dangerous to extrapolate conclusions from other such species (Falcão et al., 2007).

The Chili has a variety of therapeutic applications in traditional medicine, due to the fact that it has phytochemical components with antioxidant properties such as carotenoids, capsaicinoids and phenolic compounds, particularly flavonoids, quercetin and luteolin. Capsaicin is the main pungent component, it is a lipophilic alkaloid and has anti-inflammatory and analgesic activity (Zimmer et al., 2012). The Chili has been used as alternative for **AGP** in broilers (Thiamhirunsopit et al., 2014), laying hens (Lokaewmanee et al., 2013) and pigs (Manzanilla et al., 2006), due to its antibacterial effect. The present work hoped to document the effect of supplementing with Chili Powder (*Capsicum annum* L. var. Cayenne) to fattening rabbits that consume commercial concentrate during the fattening phase on the productive performance, the carcass and the digestibility of the diet.

Weight live at 65 d (2028g) was slightly lower than that reported by Castaño and Cardona (2015; 2169g). These results suggest that our concentrate and our handling under experimental conditions were suitable for fattening rabbits. However, and different from what was expected, the addition of chili pepper to the diet did not affect live weight at slaughter. It has been suggested that **AGP** are counterproductive for species that have a large part of their digestion with microbes, due to their atimicrobial nature (Falcão et al., 2007); but our results, do not show a negative effect on weight.

The **AGP** has been shown to improve performance in rabbits (Falcão et al., 2007), but we did not find this effect in our work. The adequate handling conditions in the experiment and the absence of an immunological challenge could explain these results; because germ-free animals do not respond to **AGP**, and they are more efficient when environmental conditions are sub-optimal (Falcão et al., 2007). Another explanation could be the level of inclusion, as will be discussed later, the levels used in this experiment could be so very low and not affect the digestibility of the diet, and therefore, not affect the productive performance.

We did not find effect of Chilli dietary incorporation on carcass and the size of different portions of the digestive system; but relative weight of liver (g kg^{-1} live weight) was lower when rabbits consumed chilli. We did not find works with similar results, or an explanation for them. But, due to the fundamental role of the liver on the metabolism of nutrients, it is important to deepen and take these results into account in future research.

Our results of diet digestibility for control treatment (698.3, 716.3, 785.8 ,789.0, and 727.0 g kg^{-1} for **DM**, **OM**, **CP**, **EE** and **GE**, respectively) were similar to reported for control diet by others researchers for (**DM,** g kg^{-1}: 700.3 -Omer et al., 2013- and 684.0 -Dorbane et al., 2019-; **OM,** g kg^{1}: 676.6 -Omer et al.,2013- and 678.0 -Dorbane et al., 2019-; **CP,** g kg^{-1}**:** 775.3 -Omer et al., 2013- and 803.0 -Dorbane et al., 2019-; **EE,** g kg^{-1}**:** 773.4 -Omer et al., 2013- and 759 -Celia et al., 2010); but higher than others research (**DM**, g kg^{-1}: 602 -Casado et al., 2010- and 499 -Celia et al., 2010; **OM**, g kg^{-1}: 612 -Casado et al., 2010- and 505 -Celia et al., 2010-; **CP**, g kg^{-1}: 712 -Casado et al., 2010- and 719 -Celia et al., 2010-; **EE**, g kg^{-1}: 623.0 -Casado et al., 2010-; **GE**, g kg^{-1}: 591 -Casado et al., 2010- and 666.0 -Dorbane et al., 2019-); these results suggest that our concentrate had adequate digestibility for fattening rabbits. We did not find effect of Chili Powder on digestibility, although there were reports about benefits of capsaicin that it could digestive stimulant action (Platel and Srinivasan, 2004). Thiamhirunsopit et al. (2014) did not found effect of Chili Powder on apparent ileal nutrient digestibility coefficients in broilers, and they concluded that capsaicin at the level of 20–30 mg kg^{-1} of feed (11.6-17.4 g of Chili Powder kg^{-1} of diet) had no effect on digestibility, and they indicated further investigation with higher concentration of capsaicin should be implemented. We use a similar inclusion of Chili Powder (20 g^{-1} kg) than Thiamhirunsopit et al. (2014), therefore, we too suggest further research with greater inclusion or Chili Powder.

4.Conclusions

The addition of Chili Meal did not affect the live weight, the feed intake, the digestibility of the diet; indicating that under the conditions of this experiment, the Chili can not be considered as a growth promoter in rabbits. The rabbits that received chili pepper had a liver with a lower relative weight, which should be cosidered in future researches.

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